

Bald Eagle

Haliaeetus leucocephalus

DESCRIPTION

The bald eagle is one of the largest and most conspicuous bird of prey in North America, second in size only to the California condor (*Gymnogyps californianus*). Its distribution is largely limited to North America, and two subspecies are tentatively recognized based on size and geographic range: the larger, northern subspecies *H. l. alascanus* and the smaller southern subspecies *H. l. leucocephalus*. Although there is disagreement on the validity and biological basis of subspecies differentiation, this account focuses on the northern subspecies, which is generally considered to include those birds breeding north of latitude 40°N (Buehler 2000). Although the wintering ranges of the two subspecies overlap, it can be assumed that only the northern subspecies occurs in the primary Housatonic study area.

The bald eagle is currently protected under the U.S. Endangered Species Act. It is federally-listed as “Threatened” in all of the 48 lower states, but is more-restrictively listed as “Endangered” (i.e., more at risk) by several New England states, including Massachusetts, Vermont, New Hampshire, and Connecticut (Massachusetts Division of Fisheries and Wildlife 2000, Degraaf and Yamasaki 2001). See Status section below for more details.

BODY SIZE

Body size of the bald eagle varies widely, with the largest birds found in the northern part of the range. Females are about 25% larger than males. Total length for adults ranges from 71 – 96 cm, with an average of 81 cm (bill tip to tail tip) for more northerly populations. Juvenile bald eagles are larger, but lighter in weight than adults of the same sex. Weights of adults and juveniles vary from 3.0 kg to over 7 kg (USEPA 1993, Buehler 2000, Canadian Fish and Wildlife Service 2000).



Figure 1. Range of the bald eagle in North America

In The Primary Study Area: No bald eagles were captured or collected in the Housatonic study area, and no site-specific or regional body size data were found.

DISTRIBUTION

The bald eagle has a breeding range from Alaska west across much of Canada, with extensive breeding populations along the Atlantic coast from the Maritime Canada to Florida and in the Great Lakes states and the Pacific Northwest (Figure 1). Breeding populations are building in the Rocky Mountains and along the Gulf Coast, and localized, spotty populations are found in all

of the lower 48 states except Rhode Island and Vermont. The winter range of the bald eagle encompasses most of the lower 48 states as well as southern portions Canada and the coastal areas of Alaska and British Columbia (Buehler 2000, Canadian Fish and Wildlife Service 2000, DeGraaf and Yamasaki 2001).

In Massachusetts, bald eagles breed and winter at the Quabbin Reservoir (part of the Connecticut River) and the Assawompsett Pond system, and overwinter along the Merimack River and along coastal shores of Cape Cod, Buzzard's Bay, Martha's Vineyard, and Nanatucket Island. They can occur anywhere within the state, especially during spring and fall migrations (Massachusetts Division of Fisheries and Wildlife 2000). They also winter in Connecticut along the Connecticut and Housatonic rivers and the large reservoirs in the Northwestern Hills (DeGraaf and Yamasaki 2001).

MIGRATION

The migration pattern of the bald eagle is complex, dependent on the age of the individual (i.e., immature vs. adult), the location of the breeding site, food availability, and the severity of the winter at the breeding site (Buehler 2000). It is thought that breeding pairs migrate independently, but may rejoin at the wintering grounds. Immatures move nomadically year round, and it is difficult to distinguish their migration movements from their dispersal movements. In winter, adults in northern portions of the range migrate out of areas where lakes and rivers freeze over completely, but appear to stay as far north as the availability of open water and reliable food supplies allow (USEPA 1993). These wintering areas may contain resident as well as migratory individuals. The far north breeding populations often migrate south in winter to areas with abundant food, such as the Mississippi and Missouri rivers, the Pacific Northwest, and the Chesapeake Bay.

Most adult winter migrations in the Northeast occur late August through early December, with peak adult migration the first half of September and peak immature migrations coming later and lasting until mid November. Northern birds return to the breeding areas in the spring as soon as

weather and food availability allow, which may be as early as January or as late as March (Buehler 2000).

HABITAT

Habitat use by bald eagles varies somewhat depending on the region, but proximity to large bodies of water with suitable foraging opportunities is critical. As such, they are generally restricted to coastal areas, lakes, and rivers. Preferred breeding sites are in forested areas adjacent to water in areas with minimal human disturbance. Large, tall conifers are often chosen for nesting, perching, and roosting. In some areas, the distance of the nest site to water is not as critical as the quality of available foraging habitat and the amount of human activity. The average distance from the nest tree to human development is >1,600 ft, with the minimum distance about 300 ft. Relatively open canopies, some type of habitat edge, and the availability of super-story trees providing good access to nests and stout horizontal perching branches are preferred habitat features for breeding pairs (USEPA 1993, Buehler 2000, DeGraaf and Yamasaki 2001).

During migrations, habitat use is most closely tied with food availability and avoidance of human activity. Stopover sites typically have traditional roost trees in suitable habitats. Winter habitats are similar to other times of year, including available open water or other food sources (i.e., carrion), and suitable roost sites that provide protection from wind and precipitation. Some communal roost sites are located long distances from aquatic foraging areas, particularly in the western states. Social interactions (i.e., information exchange) may also play a role in roost-site selection (Buehler 2000, DeGraaf and Yamasaki 2001).

A radio-tagging study in Chesapeake Bay in Maryland (Buehler *et al.* 1991c) determined the relationship between bald eagle distribution and human activity. Less than 5% of the 1,117 radio locations occurred within developed areas (i.e., ≥ 4 buildings per 9.1 acres within 1,640 ft of the shoreline), even

though over 18% of the potential eagle habitat was considered developed. The greater the building density, the less the eagle used those shoreline areas. Mean eagle flush distances elicited by approaching boats were 869 ft in winter and 575 ft in summer, and there were no significant differences in flush distances between adults and immatures.

In The Primary Study Area: Table 1 contains a summary of the literature review and observational data on the use by bald eagles of the natural community types found within the primary study area.

HOME RANGE AND TERRITORIALITY

Home range sizes of bald eagles vary widely depending on the area, season, availability of and distance to food resources, and the breeding status of the individual (Buehler 2000). Breeding adults in Saskatchewan utilized home ranges no smaller than 1,730 acres in size (Gerrard *et al.* 1992a). Garrett *et al.* (1993) reported that average home range sizes during breeding season on the Columbia River, OR, was 5,337 acres.

Immature bald eagles generally occupy much larger areas than breeding adults, presumably because they are not tied to a nest site. Nonbreeding birds hatched on the northern Chesapeake Bay ranged throughout the Chesapeake area year round, and some traveled to Maine and Maritime Canada in summer and returned in the winter (Buehler *et al.* 1991). Two radio-tracked immatures, one from the Southwest U.S. and one from the Great Lakes area, were shown to use summer ranges of more than 13.6 million acres each, with winter home ranges of more than 5 million for one and 9 million acres for the other (Buehler 2000).

Griffin and Baskett (1985) reported winter home range sizes of juvenile and adult bald eagles in Missouri to be 4,522 acres ($\pm 3,608$ SD) and 4,645 acres ($\pm 2,224$ SD), respectively. Craig *et al.* (1988) reported that linear foraging distances for eagles wintering on the Connecticut River ranged from 1.9 to 4.3 miles. Eagles that roost together in large numbers in winter share a common foraging home range (USEPA 1993).

Table 1. Habitat use by bald eagle in the primary study area

Habitat Codes and Natural Community Classifications																				
Wetland Habitats												Terrestrial Habitats								
ROW	ROW & PAB	SHO		PFO				PSS	PEM		WM	VP	SW	MW	HW			OF	AGR	RES
Medium-gradient stream	Low-gradient stream	Riverine pointbar and beach	Mud flat	Red maple swamp	Black ash-red maple-tamarack calcareous seepage swamp	Transitional floodplain forest	High-terrace floodplain forest	Shrub swamp	Deep emergent marsh	Shallow emergent marsh	Wet meadow	Woodland vernal pool	Spruce-fir-northern hardwood forest	Northern hardwoods-hemlock-white pine forest	Successional northern hardwood forest	Red oak-sugar maple transitional forest	Rich mesic forest	Cultural grassland	Agricultural cropland	Residential development
Y	Y	Y	Y																	

ROW = Riverine Open Water

VP = Vernal Pool

SW = Softwood Forests

MW = Mixed Forests

HW = Hardwood Forests

OF = Open Fields

AGR = Agricultural Croplands

RES = Residential

SHO = Shorelines

PFO = Palustrine Forested

PSS = Palustrine Scrub-Shrub

PEM = Palustrine Emergent

WM = Wet Meadow

PAB = Palustrine Aquatic Bed

Season of Use

B = Breeding

M = Migration

W = Wintering

Y = Year-round

Shading = observed in study area

Bald eagles are territorial, most notably during the breeding season. Both sexes will exhibit defense behavior towards eagles that intrude on their nesting territory during the incubation and brooding periods. The rest of their home range is not defended. Defenses include posturing (e.g., perching conspicuously), threat vocalizations, and sometimes chasing. Territorial defense generally ceases following fledging of the young, and birds often roost communally at the wintering sites without exhibiting territorial behavior (Buehler 2000).

Estimates of bald eagle territory size vary. In a Minnesota study designed to elicit defensive behaviors, the average territory radius for 10 pairs was about 1,900 ft, which would be approximately 247 acres if a circular territory is assumed (Mahaffy and Frenzel 1987). Stalmaster (1987) indicated a typical territory size of 247 – 494 acres, while Gerrard *et al.* (1992) reported a minimum territory size for a radio-tagged pair of 988 acres.

BREEDING

Courtship begins mid to late winter among northern populations. In Massachusetts, the breeding and nesting season begins in March (Massachusetts Division of Fisheries and Wildlife 2000). Bald eagles have one brood per year throughout their range. Courtship involves a spectacular array of aerial displays. Bald eagle pairs are thought to be monogamous, and pair bonds probably remain intact year to year until one of the mates dies (Harmata 1984, Buehler 2000). Nest building or maintenance begins about 1 – 3 months before egg-laying, with the males generally bringing sticks and other materials to the female for her placement within the nest. The same nest sites are used in successive years (up to 35 years recorded), though pairs may use alternate nests within the territory, particularly after nesting failure or disturbance. Nests can become very large after repeated use (Buehler 2000, DeGraaf and Yamasaki 2001).

In Massachusetts, eggs are laid in late March to early April. Clutch size ranges from 1 – 3, but is typically 2. Eggs are laid one at a time, with one or more days in between successive eggs. Laying

is usually completed in 3 – 6 days, and the female does about 75% of the incubation. Re-laying can occur, particularly when there are nest failures early in nesting season. The incubation period is 35 days, with the first egg laid being the first to hatch. Differences in hatch dates give first hatchling a competitive advantage over later arrivals (Buehler 2000, Massachusetts Division of Fisheries and Wildlife 2000). Most 3 egg clutches do not produce 3 fledglings because the last-borne chick dies of starvation (Gerrard and Bortolotti 1988).

GROWTH AND DEVELOPMENT

Competition for food among the nestlings is intense, particularly when the parents are not able to provide enough food for all of their young. The oldest sibling uses its greater size to get most of the food, sometimes causing the younger siblings to starve. Gerrard and Bortolotti (1988, as cited in Buehler 2000) reported weights from one nest were 477, 260, and 80 g for 9-day-old, 8-day-old, and 6-day-old siblings, respectively. Sibling competition is greatest early in the nesting season when size differences are greatest (Bortolotti 1986, as cited in Buehler 2000). This behavior increases the likelihood that at least one of the chicks will survive to fledge.

The young eaglets are born covered with down, but begin to grow flight and body feathers in the first 2 – 4 weeks. Growth is rapid, with maximum average growth (at 3 – 4 weeks of age) of 102 g/d for males and 130 g/d for females recorded in a Saskatchewan study (Bortolotti 1984, as cited in Buehler 2000). Both parents bring food to the nest, at first tearing off pieces for the young birds. At about 6 weeks old, nestlings begin to tear off food and feed themselves (Palmer *et al.* 1988). The female parent may do the majority of feeding after the first 2 weeks. Adults deliver food several times a day.

Nest departure occurs at about 8 – 14 weeks. Prior to first flights, the young eaglets flap their wings to develop strength and coordination, moving about in the nest or to

adjacent limbs. Some first flights are unsuccessful, and the young may spend time (e.g., days or weeks) on the ground until gaining flight ability. Parents will continue to feed these birds.

Even after flight ability is gained, nestlings may use the nest as a feeding platform for several weeks (Buehler 2000). The fledglings associate with other young and adults for several weeks prior to dispersal, and may still be fed by adults and do not catch live prey for up to 6 weeks after leaving the nest. Hunting skills may be developed by trial and error rather than learned from parents. (Kussman 1977, as cited in Buehler 2000).

After their initial dispersal, immature bald eagles spend about 4 years exploring until they develop adult plumage. Dispersal direction from the nest area is variable, even among siblings. In Maine, the newly fledged birds dispersed to the coast, generally southward (McCullough 1986). Immatures show little fidelity to any one area, but move in response to food availability and weather in patterns that may repeat year after year (Buehler 2000).

FOOD HABITS AND DIET

Bald eagles are opportunistic feeders, eating a variety of animals either taken as live prey or scavenged as carrion. Fish is the preferred food throughout the range and often makes up a large proportion of the total diet (Stalmaster 1987). Depending on availability, scavenged dead or dying fish will be utilized more than live fish due to the bald eagle's limited fishing ability. When fishing, eagles will choose shallow water where fish are more likely to be close to the surface. Benthic-dwelling fish species (e.g., bullheads) are probably most often taken dead, floating on the surface (Mersmann 1989, as cited in Buehler 2000). Bald eagles often take advantage of fish kills associated with natural or human-caused events (e.g., post-spawning salmon mortality, summer oxygen-depletion kills, hydroelectric turbine outfalls) (Knight and Knight 1983, Buehler 2000). Availability plays a large role in regard to which fish species are taken. In some wintering areas, eagles will congregate in large numbers to feed on readily available food, particularly fish.

Many other types of food are opportunistically utilized by bald eagles throughout their range, including mammals, birds, reptiles, crustaceans, and sometimes garbage. Virtually any dead aquatic or terrestrial animal is a potential food. Eagles also prey on live animals such as waterfowl, gulls, shorebirds, muskrat (*Ondatra zibethicus*), raccoon (*Procyon lotor*), hares (*Lepus* spp.), squirrels, and small mammals. Deer and sometimes livestock carcasses are utilized when available (Todd *et al.* 1982, Knight and Knight 1983, USEPA 1993, Buehler 2000). Todd *et al.* (1982) identified 64 species of vertebrates and 2 species of invertebrates in nest-site food remains of Maine bald eagles, with fish making up >75% of the items. Fish were more common food items at the inland nest sites, while mammals use was greatest at the coastal sites.

Bald eagles forage by direct capture, scavenging, or stealing food from other animals. Eagles most often hunt in flight or from perches. They will often steal food from other eagles as well as from osprey (*Pandion haliaetus*), herons, and sometimes mammals. Adults are more successful than immatures at capturing live prey. Food piracy is more common in the non-breeding season (Todd *et al.* 1982, Knight and Knight 1983, Buehler 2000). Eagles also will displace mammals and other birds at carrion sites (McCullough *et al.* 1994). Foods are most often taken to a nearby perch or brought to the nest for consumption, though if left undisturbed, eagles will feed on large items on the ground. Eagles can gorge and store food in their crops to be digested over several days. Prolonged fasting in captivity (16 or more days) has been observed with little adverse health effects (Stewart 1970, as cited in Buehler 2000).

Because bald eagles scavenge dead or dying prey, they are susceptible to contaminants such as pesticides, toxic chemicals, and lead shot that may be present in these foods. In addition, bald eagles are vulnerable to biomagnification of contaminants because of their position in the food chain (USEPA 1993).

ENERGETICS AND METABOLISM

Stalmaster and Gessaman (1982, as cited in Buehler 2000) measured energy requirements of captive bald eagles and found that daily gross energy intake, existence metabolism, and excretory energy were 425.5, 341.9, and 83.6 kJ/kg at 5°C, respectively, though it is estimated that energy and food requirements would be 10% higher in the wild (Stalmaster and Gessaman 1984, as cited in Buehler 2000). Ecological metabolism estimates based on food consumption of wintering eagles on the Connecticut River (Craig *et al.* 1988) were 1,873 kJ/bird/d (SD = 72) for adult daily energy budget and 2,249 kJ/bird/d (SD = 77) for adult daily energy consumption. Stalmaster and Gessaman (1984) reported a basal metabolic rate of captive bald eagles, as measured by oxygen consumption at various ambient conditions, to be 11.595 kJ/g/h. The metabolic rate was inversely related to ambient temperature, and increased in response to induced rainfall.

MOLT

Immature bald eagles go through a sequence of plumages before attaining the distinctive adult plumage at 4.5 to 5.5 years of age. Plumage is highly variable depending on the season and age. McCollough (1989) and Buehler (2000) present comprehensive descriptions of the plumage stages and molting sequences for the various immature through adult stages.

Adult bald eagles molt every year, though it is thought that some feathers may be retained for 2 years. Juveniles (through the 1st-year) and immatures (years 2 through about 4.5 – 5.5) also undergo annual molts. Molting begins in the spring of the year and continues through summer and fall (total time = ± 6 months) in northern populations (McCollough 1989).

POPULATIONS AND DEMOGRAPHY

Survivorship and Mortality: Survivorship likely varies somewhat among eagle populations and regions, though the data that have been collected suggests excellent survival for most age classes. In Maine, McCollough (1986) found that at least 73% of juveniles survived their first year. In

Chesapeake Bay (MD and VA), Buehler *et al.* (1991a) found that the mean minimum survival per year for 39 eagles (tagged as 8- to 10-week-old eaglets) from 1984 to 1990 was 91% (95% CI = 86 – 96%) and mean maximum survival was 98% (95% CI = 96 – 100%). All 39 survived the first year, and survival estimates were similar for most age classes up to age 6. There were only 2 documented cases of mortality in addition to the 9 eagles whose radio signals were lost. Buehler (2000) suggests that, as a species, bald eagles may typically follow the survival patterns of other raptors, where survival is lowest in the first year followed by increasing survival to adulthood. Adult survival has been found to be high in other regions, including 100% in Florida (Wood 1992) and 88% in Alaska (Bowman *et al.* 1995). Migratory populations may have slightly lower survivorship (Buehler 2000).

Human activities account for the greatest single cause of bald eagle mortality. Wood *et al.* (1990, as cited in Buehler 2000) reported that 68% of 1,428 individuals necropsied from 1963 to 1984 had died as a result of human activity of some type. Direct causes of mortality include accidental or intentional trapping, shooting, and poisoning. Indirect human-caused mortalities include primarily those from collisions with vehicles and powerlines, exposure to pesticides and contaminants, and ingestion of lead and plastic.

Pesticides and contaminants have a high potential to affect bald eagles because of the high trophic level that this species occupies (i.e., as it relates to the concept of biomagnification). In the last century, bald eagles have been subjected to a wide variety of chemical pollutants in the environment, experiencing both direct poisoning and decreased reproduction. DDE (1,1-dichloro-2,2-bis(p-chlorophenyl)ethylene), a metabolite of the pesticide DDT (1,1,1-trichloro-2,2-bis(p-chlorophenyl)ethylene), has been linked to reproductive failures and eggshell thinning in bald eagles and other raptors. Anthony *et al.* (1993) found that high levels of DDE and

PCBs were associated with eggshell thinning and decreased productivity among bald eagles in the Columbia River Estuary. They also found detectable levels of these substances in the blood of nestlings, indicating that eagles can be exposed early in life. There is speculation that PCBs (polychlorinated biphenyls) also contribute to reproductive failure through eggshell thinning, but their effects on reproduction are not well understood (Buehler 2000).

Cyclodiene pesticides, particularly Dieldrin, have been implicated in mortality of bald eagles from the Midwest from the late 1960s to the early 1980s. Other types contaminants and heavy metals also pose a continual threat to eagles, who often become poisoned when they consume prey that has been sickened or poisoned by consumption of these materials. Lead poisoning is also relatively common in eagles, the source being lead shot in waterfowl and lead fishing sinkers (Buehler 2000).

Age at Maturity and Life Span: The majority of bald eagles reach sexual maturity at 5.5 years of age, though it has been shown that they are capable of first breeding as young as 3 years of age. Breeding may occur at the earlier ages in populations that are below their carrying capacity, or may not begin until as late as 6 or 7 years in dense populations. Bald eagles have been shown to live up to 28 years in the wild and 36 years in captivity (Buehler 2000).

Enemies: Adult bald eagles have few natural enemies. Eggs, nestlings, and fledglings are susceptible to predation by avian and mammalian predators, including hawks, owls, ravens, crows, gulls, raccoons, black bears, and others. Diseases and parasites have been identified, though relatively little is known about their incidence or effect on mortality. Neither predation nor natural diseases are considered significant sources of mortality among bald eagles (Buehler 2000).

STATUS

General: Declines in bald eagle populations beginning in the mid 1800's led to the passage in 1940 of the Federal Bald Eagle Protection Act (16 U.S.C. 688). Further declines resulting from DDT exposure and habitat loss from the 1940s to the

1960s prompted the listing of the southern subspecies (i.e., those populations south of the 40th parallel) under the Endangered Species Preservation Act of 1966. In 1978, protection was expanded to bald eagles in all 48 lower states, with a few northern states' populations listed as Threatened and the rest as Endangered. The ban on DDT in the 1970s, enforcement of the Endangered Species Act, and active, ongoing restoration and management efforts by the U.S. Fish and Wildlife Service have allowed most bald eagle populations in the lower 48 states to rebound dramatically. Because of the healthy population increases and range expansions, the bald eagle was downgraded in 1995 to Threatened at the federal level in all of the lower 48 states. In New England, however, the states of Massachusetts, Vermont, New Hampshire, and Connecticut still list the species as Endangered due to the low numbers of breeding pairs in their respective states (Massachusetts Division of Fisheries and Wildlife 2000).

Bald eagle populations throughout the species' range have been increasing steadily since conservation efforts began. Buehler (2000) reports that the population estimate in 1980 was 70,000 birds in North America. The current (1999) estimate for all of North America is on the order of 100,000 individuals, with the greatest numbers still in Alaska and British Columbia. A 66% increase in the number of adults in Alaska from 1967 to 1997 is attributed to reduced mortality rather than elimination of DDT effects, because DDT was not a problem in Alaska. Populations in Alaska, Florida, Michigan, Minnesota, Wisconsin, Washington, and Oregon may be at or near carrying capacity, while other areas (e.g., New Hampshire and Connecticut) have fewer than 3 breeding pairs each (Buehler 2000).

Bald eagles were confirmed as successfully breeding in Massachusetts in 1989, after being absent for more than 80 years. This followed a reintroduction program in the mid-1980s in which 41 young eagles from Michigan and Canada were brought to Quabbin Reservoir in

the central part of the state. As of 1995, there were 9 pairs known to be nesting in the state, with nests located at Quabbin Reservoir, Connecticut River, and Plymouth County (Massachusetts Division of Fisheries and Wildlife 2000).

In The Primary Study Area: Bald eagles were observed only infrequently during the 1998, 1999, and 2000 field surveys in the study area. A total of 7 sightings were recorded (Figure 2), including both adults and immatures. Sightings were limited to the spring and fall seasons. Eagles were seen feeding in Woods Pond and in backwaters north of the pond. No nesting is known to occur within the primary study area

REFERENCES

- Anthony, R.G., M.G. Garrett, and C.A. Schuler. 1993. Environmental contaminants in bald eagles in the Columbia River Estuary. *Journal of Wildlife Management* 57(1):10-19.
- Bortolotti, G.R. 1984. Physical development of nestling bald eagles with emphasis on the timing of growth events. *Wilson Bulletin* 96:524-542.
- Bortolotti, G.R. 1986. Evolution of growth rates in eagles: sibling competition vs. energy considerations. *Ecology* 67:182-194.
- Bowman, T.D., P.F. Schempf, and J.A. Bernatowicz. 1995. Bald eagle survival and populations dynamics in Alaska after the Exxon Valdez oil spill. *Journal of Wildlife Management* 59:317-324.
- Buehler, D.A. 2000. Bald Eagle (*Haliaeetus leucocephalus*). p. 1-39. In A. Poole and F. Gill (ed.) *The Birds of North America*. Vol. 506. The Birds of North America, Inc., Philadelphia, PA, USA. (N)
- Buehler, D.A., J.D. Fraser, J.K.D. Seegar, G.D. Therres, and M.A. Byrd. 1991a. Survival rates and population dynamics of bald eagles on Chesapeake Bay. *Journal of Wildlife Management* 55(4):608-613.
- Buehler, D.A., T.J. Mersmann, J.D. Fraser, and J.K.D. Seegar. 1991b. Differences in distribution of breeding, nonbreeding, and migrant bald eagles on the northern Chesapeake Bay. *Condor* 93:399-408.

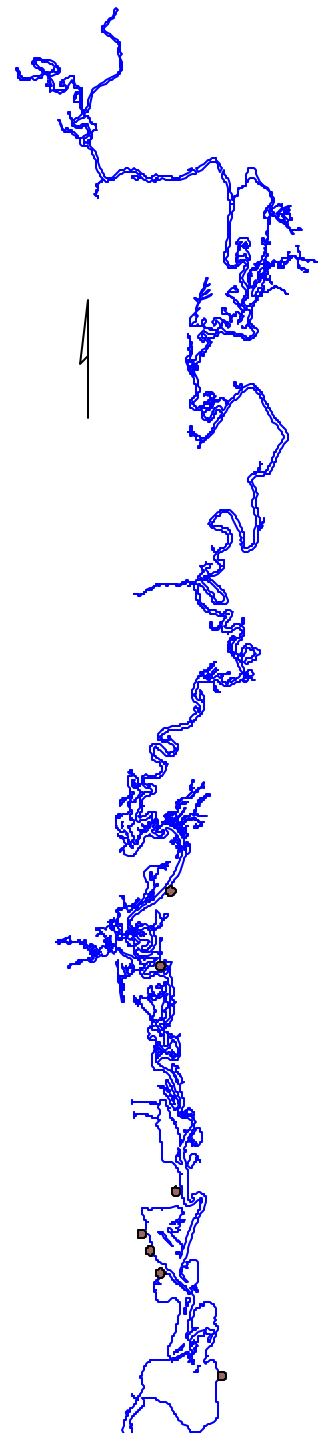


Figure 2. Bald eagle sightings in the primary study area, from 1998 – 2000 field studies.

- Buehler, D.A., T.J. Mersmann, J.D. Fraser, and J.K. Seegar. 1991c. Effects of human activity on bald eagle distribution on the northern Chesapeake Bay. *Journal of Wildlife Management* 55(2):282-290.
- Canadian Fish and Wildlife Service. 2000. Hinterland Who's Who: Bald Eagle. URL <http://www.cws-scf.ec.gc.ca/hww-fap/bald/bald.html>.
- Craig, R.J., E.S. Mitchell, and J.E. Mitchell. 1988. Time and energy budgets of bald eagles wintering along the Connecticut River. *Journal of Field Ornithology* 59:22-32.
- DeGraaf, R.M., and M. Yamasaki. 2001. *New England Wildlife: Habitat, Natural History, and Distribution*. University Press of New England, Hanover, NH.
- Gerrard, J.M., and G.R. Bortolotti. 1988. *The Bald Eagle: Haunts and Habits of a Wilderness Monarch*. Smithsonian Institution Press, Washington, D.C., USA.
- Gerrard, J.M., P.N. Gerrard, G.R. Bortolotti, and E.H. Dzus. 1992a. A 24-year study of bald eagles on Besnard Lake, Saskatchewan. *Journal of Raptor Research* 26:159-166.
- Gerrard, J.M., A.R. Harmata, and P.N. Gerrard. 1992b. Home range and activity of a pair of bald eagles breeding in northern Saskatchewan. *Journal of Raptor Research* 26:229-234.
- Griffin, C.R., and T.S. Baskett. 1985. Food availability and winter range sizes of immature and adult bald eagles. *Journal of Wildlife Management* 49:592-594.
- Harmata, A.R. 1984. *Bald eagles of the San Luis valley, Colorado: their wintering ecology and spring migration*. Ph.D. Dissertation. Montana State University, Bozeman, MT, USA.
- Knight, S.K., and R.L. Knight. 1983. Aspects of food finding by wintering bald eagles. *Auk* 100:477-484.
- Kussman, J.V. 1977. *Post-fledgling behavior of the northern bald eagle (Haliaeetus leucocephalus), in the Chippewa National Forest, Minnesota*. Ph.D. Thesis. University of Minnesota, Minneapolis, MN, USA.
- Mahaffy, M.S., and L.D. Frenzel. 1987. Elicited territorial responses of northern bald eagles near active nest sites. *Journal of Wildlife Management* 51:551-554.
- Massachusetts Division of Fisheries and Wildlife. 2000. *Natural Heritage and Endangered Species Program*. Westborough, MA. URL <http://www.state.ma.us/dfwele/dfw/nhesp/>.
- McCollough, M.A. 1986. *The post-fledging ecology and population dynamics of bald eagles in Maine*. Ph.D. Dissertation. University of Maine, Orono, ME, USA.
- McCollough, M.A. 1989. Molting sequence and aging of bald eagles. *Wilson Bulletin* 101:1-10.
- McCollough, M.A., C.S. Todd, and R.B. Owen. 1994. Supplemental feeding program for wintering bald eagles in Maine. *Maine Wildlife Society Bulletin* 22:147-154.
- Mersmann, T.J. 1989. *Foraging ecology of bald eagles on the northern Chesapeake Bay with an examination of techniques used in the study of bald eagle food habits*. M.S. Thesis. Virginia Polytechnic Institute and State University, Blacksburg, VA, USA.
- Palmer, R.S., J.S. Gerrard, and M.V. Stalmaster. 1988. Bald Eagle. p. 187-237. *In* R.S. Palmer (ed.) *Handbook of North American Birds*. Vol. 4. Yale University Press, New Haven, CT, USA.
- Stalmaster, M.V. 1987. *The Bald Eagle*. Universe Books, New York, NY, USA.
- Stalmaster, M.V., and J.A. Gessaman. 1982. Food consumption and energy requirements of captive bald eagles. *Journal of Wildlife Management* 46:646-654.
- Stalmaster, M.V., and J.A. Gessaman. 1984. Ecological energetics and foraging behavior of overwintering bald eagles. *Ecological Monographs* 54:407-428.
- Stewart, P.A. 1970. Weight changes and feeding behavior of a captive-reared bald eagle. *Bird-banding* 41:103-110.

- Todd, C.S., L.S. Young, R.B. Owen, and F.J. Gramlich. 1982. Food habits of bald eagles in Maine. *Journal of Wildlife Management* 46:636-645.
- USEPA. 1993. *Wildlife Exposure Factors Handbook*. Volume 1 of 2. EPA/600/R-93/187a. U.S. Environmental Protection Agency, Office of Research and Development, Washington, DC, USA.
- Wood, P.B. 1992. Habitat use, movements, migration patterns, and survival of subadult bald eagles in North Florida. Ph.D. Dissertation. University of Florida, Gainesville, FL, USA.
- Wood, P.B., D.A. Buehler, and M.A. Byrd. 1990. Raptor Status Report - Bald Eagle. p. 13-21. *In* B.G. Pendleton (ed.) *Proceedings of the Southeast Raptor Management Symposium and Workshop*. National Wildlife Federation, Washington, DC, USA.